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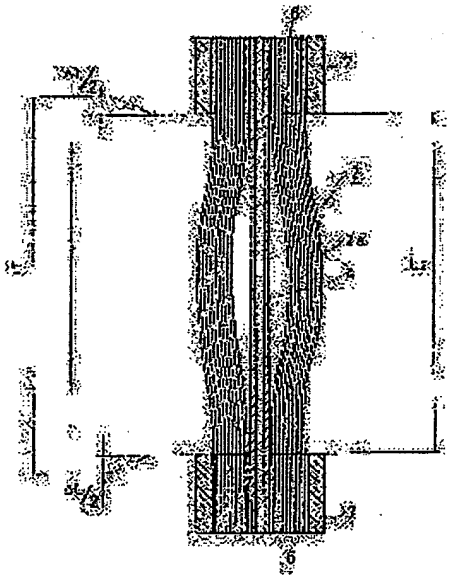
(71)Applicant : **TOSHIBA CORP**

(72)Inventor : **TAMURA KUNIO**

(54) HOLLOW YARN MEMBRANE FILTER

(57)Abstract:



PURPOSE: To prevent the damage of a hollow yarn and to perform effective backwashing, by a method wherein hollow yarns are arranged so that the length of each of the hollow yarns between both adhesive filling parts is so excessive as to satisfy a specific condition with respect to the interval between both adhesive filling parts.

CONSTITUTION: In a hollow yarn membrane filter 2, the length L1 of each of the hollow yarns 2a arranged in a slightly loosened state between upper and lower end adhesive filling parts 6 is set so that an excessive length ΔL satisfies the relation $0.01 \leq \Delta L/L1 \leq 0.04$ (wherein $\Delta L = L1 - L2$) with respect to the distance L2 between both adhesive filling parts 6. By this method, the whirling-up of the hollow yarns 2a at the time of backwashing and the accompanying entanglement, bending or breakage can be prevented and, since the hollow yarns 2a are shaken properly, effective backwashing can be performed. Further, a solid component released at the time of backwashing is not accumulated in the hollow yarn membrane filter 2. Furthermore, a liquid effectively flows around the hollow yarns 2a positioned at a central part at the time of filtering.

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(30) Priority:	(71) Applicant: TOSHIBA CORP
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(54) HOLLOW YARN MEMBRANE FILTER

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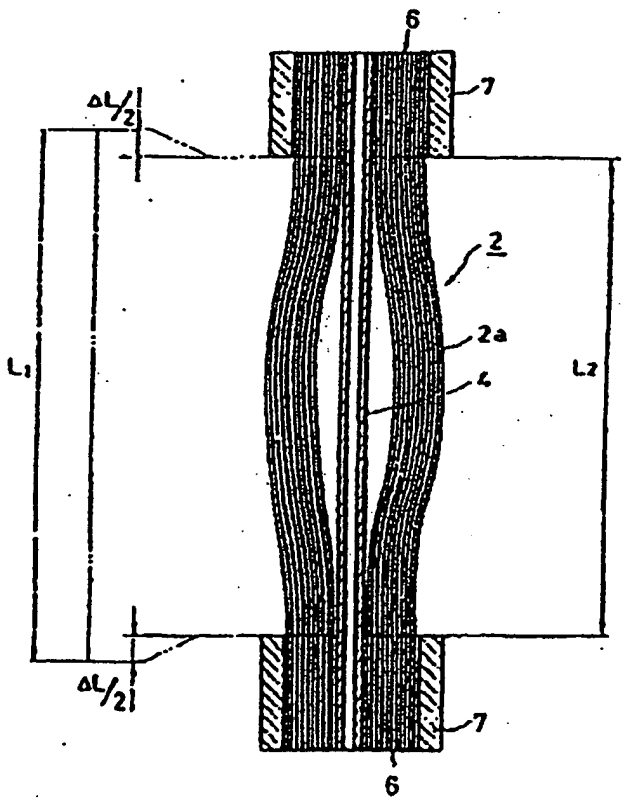

⑲日本国特許庁(JP)　⑪特許出願公開

⑫公開特許公報(A)　昭63－143905

⑤Int.Cl.⁴	識別記号	庁内整理番号	⑬公開　昭和63年(1988)6月16日
B 01 D 13/01		6953－4D	

審査請求　未請求　発明の数 1　(全5頁)

⑤発明の名称　中空糸膜フィルタ

⑪特　願　昭61－282045
⑫出　願　昭61(1986)12月8日

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⑭代 理 人　弁理士 鈴江 武彦　外2名

明　細　書

1．発明の名称

中空糸膜フィルタ

2．特許請求の範囲

複数本の中空糸を束ねてその両端開口部が開口するように接着剤を充填して固定し、上記接着剤を充填した接着剤充填部の外周に補強固定部材を設置して固定して上記両端の接着剤充填部を所定長さをもって造成する中空糸膜フィルタにおいて、上記両端接着剤充填部間の中空糸の長さ（L_1）は上記両端接着剤充填部間の間隔（L_2）に対して所定の余長（ΔL）を持って配設され、この余長（ΔL）は以下の条件を満足するものであることを特徴とする中空糸膜フィルタ。

$0.01 \leq (\Delta L / L_1) \leq 0.04$

但し

L_1：両端接着剤充填部間に配設される中空糸の長さ

L_2：両端接着剤充填部間の間隔

ΔL：$(L_1 - L_2)$

3．発明の詳細な説明

【発明の目的】

（産業上の利用分野）

本発明は各種プラントの水処理装置において、被処理液中の固形分を分離・除去する目的で使用される中空糸膜フィルタに関する。

（従来の技術）

一般に中空糸はその外径が0.3～3 mm程度で、その表面に微細な穴を有する中空円状の繊維の束である。そして単位容積内の膜面積を大きくとることができるとともに、耐圧性に優れているという特徴を備えている。そこで中空糸を多数本束ねてその両端を接着剤である樹脂で固めることによりフィルタを形成する。この中空糸膜フィルタを水処理装置用の膜濾過器として使用する。

以下第5図を参照してそのような中空糸膜濾過器の構成を説明する。第5図は中空糸膜濾過器の断面図であり、図中符号1は容器本体である。この容器本体1内は仕切板3により上下に二分されており、下部空間を濾過室1aとし、上部空間

を処理液室1bとしている。上記被処理室1a内には中空糸膜フィルタ2が上記仕切板3より垂下されている。上記中空糸膜フィルタ2は支持体4の外周に多数本の中空糸2aを集束させて、その上端部及び下端部を接着剤充填部6で固定するとともに、更にその外側から集束固定部材7を装着して固定した構成となっている。また第1図に示す装置では上記構成をなす中空糸膜フィルタ2を鉛直方向に2段連結しており、図中符号8はその際使用される連結具である。上記容器本体1の下端部には被処理室1aに連通する被処理液給配管10が接続され、一方上端部には処理液室1bに連通する処理液排出配管11が接続されている。上記被処理液給配管10には開閉弁12が介挿されており、濃縮液排出配管13が分岐接続されている。この濃縮液排出配管13には開閉弁14が介挿されている。上記被処理液給配管10を介して被処理室1a内に供給された液は、中空糸膜フィルタ2を通過する際に濾過されて各中空糸2aの中空部を介して排出される。

上記構成にあって、濾過により中空糸膜フィルタ2の表面の差圧が上昇して、これが所定値に達した場合には、濾過操作を停止して各中空糸2aの表面に付着した固形分を洗い落とす操作が行われる。すなわち前記処理液排出配管11を介して中空糸膜フィルタ2の各中空糸2a内に逆洗用の加圧気体を供給する。それと同時に中空糸膜フィルタ2の下方からバブリング操作を施す。つまり前記容器本体1内にあって中空糸膜フィルタ2の下方にはバブリング管15が配設されており、このバブリング管15の下面部には気泡孔16が形成されている。また上記バブリング管15は開閉弁18を有するエアー供給管17に接続されている。そして上記バブリング管15に上記エアー供給管17を介してエアーを供給することにより気泡孔16より気泡を発生させる。該気泡により中空糸膜フィルタ2をバブリングさせて洗浄効果を高める。尚前記仕切板3の下方位置の容器本体1にはオーバーフロー管19が接続されており、該オーバーフロー管19には開閉弁20が介挿されている。また図中符号21は逆洗管であって、この逆洗管21によって上述したバブリングの際の気泡を中空糸膜フィルタ2内に効果的に導入するものである。

ところで上述した構成の中空糸膜フィルタ2に対して逆洗を施す際、両端部の接着剤充填部6によって決定される両端間の距離（第5図中符号L_2で示す）に対して、その間に配置される中空糸2aの長さ（L_1、上記L_2なる距離の間で若干弛んでいるのでL_2より大きな値である）をどの程度の余長をもって決定すれば、前述したバブリングが効果的になされかつ中空糸2aの損傷等が防止できるかについては考慮されていないのが現状である。従来は5%程度の余長をもって設定していた。ところが、濾過・逆洗を繰返すうちに複数本の中空糸2aがからみついて屈曲・破損するという事態が発生した。これは中空糸2aが高分子材料からなり、被処理液の主成分である水とその比重が殆ど等しい為に、中空糸2aが舞い上がり屈曲・破損に至ったものと考えられる。このような問題を解決する手段としては、前記5%程度に設定した余長を短くする、あるいは無くすことが考えられる。しかしながらその様な方法をとった場合には以下のような問題が生ずる。

①まず前述したバブリングを行なう際の中空糸2aの揺動幅が必要以上に制限されて、十分なバブリング効果を得ることができない。

②中空糸膜フィルタ2は前述したように複数本の中空糸2aが密に配列された状態で集束されており、余長を少なくすると、各中空糸2a間に気泡が効果的に浸透せず、よって中空糸膜フィルタ2の外周に位置する中空糸2aのみが揺動される結果となる。これは逆洗効率の点からも望ましくなく、又外周に位置する中空糸2aのみに固形分が付着するという現象が発生してしまう。

③また逆洗を施した場合に、濾過液により剥離した固形分が中空糸2a間に溜ってしまい、剥離した固形分の排出が効率良く行われないという問題がある。これら諸問題と同様に中空糸2aが密に配設されかつ余長が少ない為にる中空糸

2a間における流通抵抗が高いことによる。

（発明が解決しようとする問題点）

このように従来の中空糸膜フィルタにあってはその余長をいかに設定するかについての十分な検討がなされてはおらず、その結果種々の問題を発生しており、本発明は以下の点に着目してなされたものでその目的とするところは、中空糸の破損を防止するとともに効率的な注洗を行なうことを可能とする余長を備えた中空糸膜フィルタを提供することにある。

〔発明の構成〕

（問題点を解決するための手段）

すなわち本発明による中空糸膜フィルタは、複数本の中空糸を束状としてその両端開口部が開口するように接着剤を充填して固定し、上記接着剤を充填した接着剤充填部の外側に液密固定部材を装着して固定して上記両端の接着剤充填部を所定長さをもって遮蔽する中空糸膜フィルタにおいて、上記両接着剤充填部間の中空糸の長さ（L_1）は上記両接着剤充填部間の直線（L_2）に対して所定の余長（ΔL）を持って配置され、この余長（ΔL）は以下の条件を満足するものであることを特徴とするものである。

$0.01 \leq (\Delta L / L_2) \leq 0.08$

但し

L_1：両接着剤充填部間に配置される中空糸の長さ

L_2：両接着剤充填部間の直線

ΔL：($L_1 - L_2$)

（作用）

中空糸の余長を上記範囲内とすることにより、余長が大きすぎる為に発生する中空糸のからみつき、それによる損傷・破断を防くとともに、余長が小さ過ぎることにより発生する逆洗効果の低下等の問題を効果的に解決するものである。

（実施例）

以下第1図乃至第4図を参照して本発明の一実施例を説明する。尚従来と同一部分には同一符号を付して示しその説明は省略する。第1図は中空糸膜フィルタ2の構成を示す断面図であり、上

端及び下端のろ過膜充填部6間に位置した状態で配置される中空糸2aの長さ（L_1）は、上記ろ過膜充填部6間の直線（L_2）に対して（ΔL）なる余長を有しており、この余長（ΔL）は以下の範囲内に設定されている。$0.01 \leq (\Delta L / L_2) \leq 0.04$ ---（I）

但し

L_1：両端ろ過膜充填部間に配置される中空糸の長さ

L_2：両端ろ過膜充填部間の直線

ΔL：($L_1 - L_2$)

余長（ΔL）をこのような範囲内に設定したのは、余長が大き過ぎることによる弊害、及び余長が小さ過ぎることによる弊害の双方を効果的に解決するためであり、以下第3図及び第4図を参照して説明する。

第3図は横軸に余長（ΔL）の中空糸2aの長さ（L_1）に対する割合をとり（%）、縦軸に中空糸2aの切断部本数（中空糸1000本当り）をとって示した図である。これによると、余長（ΔL）の中空糸2aの長さ（L_1）に対する割合が4以下の場合には切断部が発生した中空糸2aの本数が極めて少ないことがわかる。よって余長（ΔL）割合を4以下にすれば余長が大きいことによる弊害を効果的に無くすことができる。一方下限値であるが、これについては第4図を参照して説明する。第4図は横軸に余長（ΔL）の中空糸2aの長さ（L_1）に対する割合をとり（%）、縦軸に逆洗効率（逆洗によって洗浄した部分量／膜目詰物分量、%）をとって示したもので、この第4図から明らかなように余長（ΔL）の中空糸2aの長さ（L_1）に対する割合が1以下になると逆洗効率が急速に悪化しているのがわかる。これは第2図にも示すように、逆洗時にパブリングを行なう際には中空糸2aがある程度振動する事があり、振動により目詰物が取れ易くなるからである。さらに以下のことが判明された。すなわち余長（ΔL）の割合を1未満とした場合には、中空糸2aの折れが必要以上に発生されるために、中空糸膜フィルタ2の中心部の中空糸2a近傍に

あっては洗浄が貫通せず、よって外周部の中空糸2aのみが洗浄に供される結果となってしまう。これは外周に位置する中空糸2aのみに懸濁分が付着することから確認することができる。それと同時に1未満とした場合には、逆洗時に剥離した懸濁分が中空糸膜フィルタ2内に残ってしまい、効果的に排出できないことも確認された。このような理由から余長(ΔL)の中空糸2aの長さ(L_1)に対する割合の下限値を1としたものである。

以上本実施例によると以下のような効果を奏することができる。

①まず逆洗時における中空糸2aの舞い上がり、それによってからみつき目詰あるいは破損するといった事態を効果的に防止することができる。

②次に逆洗時には中空糸2aが自由に揺動するので、効果的な逆洗が可能となる。

③また逆洗時に剥離した懸濁分が中空糸膜フィルタ2内に残ってしまうということもない。

④さらに通水時にあっても中空糸膜フィルタ2の中心部に位置する中空糸2aの周りにも通水が均等的に供給するので、外周部のみで通水が行われるといった事態を防止することができ、効率のよい通水を提供することができる。

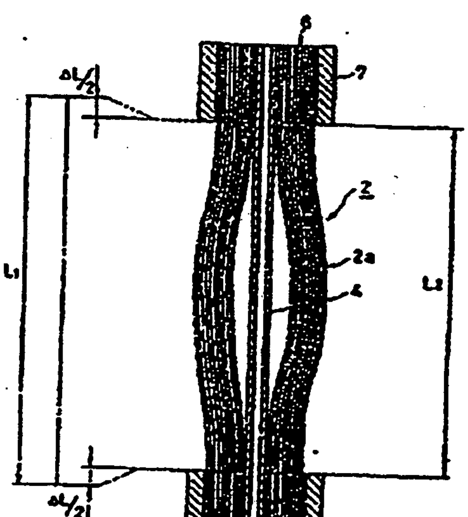
〔発明の効果〕

以上詳述したように本発明による中空糸膜フィルタによると、中空糸の舞い上がり、それによるからみつき、さらには目詰・破損といった事態を防止することができるとともに、効果的な逆洗を提供することができる等その効果は大である。

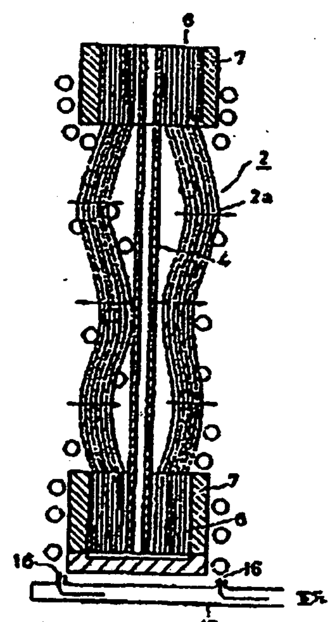
4. 図面の簡単な説明

第1図乃至第4図は本発明の一実施例を示す図で、第1図は中空糸膜フィルタの正面図、第2図は逆洗時の状態を示す中空糸膜フィルタの正面図、第3図は中空糸の余長を変化させた場合の目詰発生本数の変化を示す特性図、第4図は中空糸の余長を変化させた場合の逆洗効果変化を示す特性図である。

2—中空糸膜フィルタ、2a—中空糸、4—支持体、6—接着固定部、7—結束固定部材。

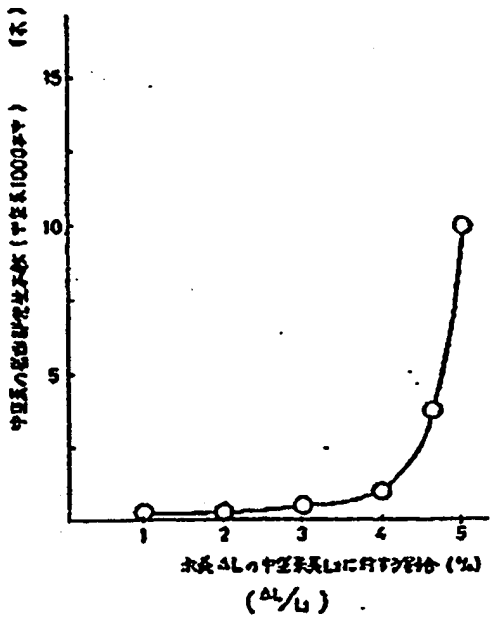


第1図

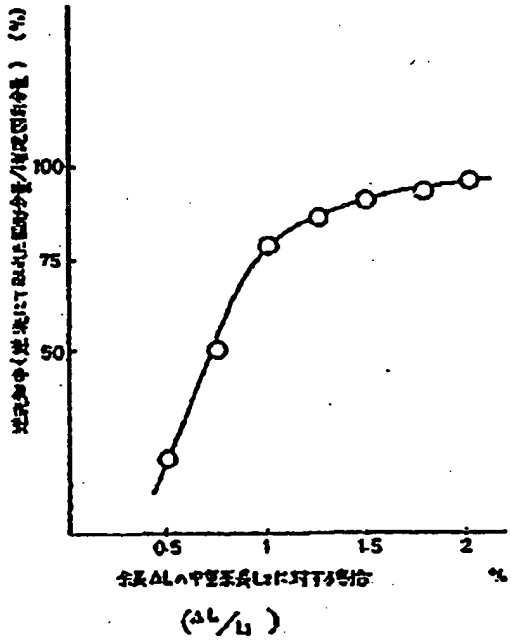


第2図

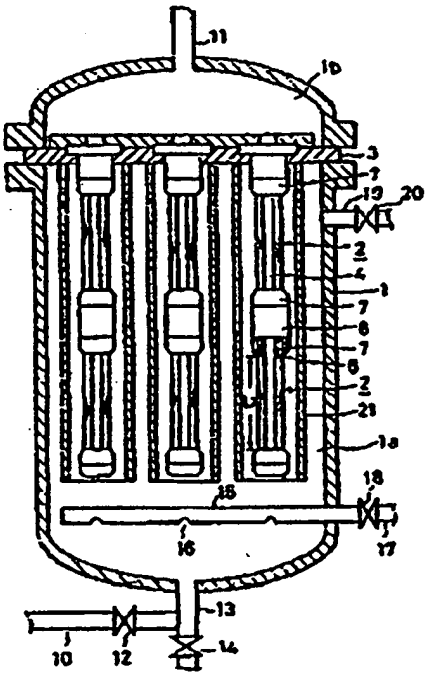
USF 093057



第 3 図



第 4 図



第 5 図

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(12) Public Patent Bulletin (A) SHO63[1988]-143905

(51) Int. Cl.[4] Identification Symbol

B 01 D 13/01

Office reference number
6953-4D

(43) Disclosure date: June 16, 1988 (Showa 63)

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Number of Inventions: 1
(Total of 5 Pages)

(54) Title of Invention: Hollow Yarn Membrane Filter

(21) Application No.: Sho 61[1986]-292045

(22) Application Date: December 8, 1986 (Showa 61)

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Specification

1. Title of the Invention

Hollow yarn membrane filter

2. Claims

In the context of a hollow yarn membrane filter in which multiple pieces of hollow yarn are bundled, filling and securing with bonding agent are performed in such a

way that both bundled ends open, a bundle securing member is installed and secured at the outer circumference of the bonding agent filling sections filled with the aforesaid bonding agent, and the aforesaid bonding agent filling sections at both ends are connected across a specified length; a hollow yarn membrane filter characterized in that the length (L1) of the hollow yarn between the aforesaid two bonding agent filling sections is set so that there is a specified excess length (ΔL) with respect to the gap (L2) between the aforesaid two bonding agent filling sections, and this excess length (ΔL) satisfies the following conditions:

$0.01 \leq (\Delta L/L1) \leq 0.04$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections
L2: The gap between the two bonding agent filling sections
ΔL: (L1 - L2)

3. Detailed Explanation of the Invention

Objective of the Invention

Industrial Field of Usage

The present invention relates to a hollow yarn membrane filter used in water treatment apparatuses in various types of plants with the objective of separating and eliminating solid portions in the liquid to be treated.

Conventional Art

In general, the hollow yarn is a membrane of hollow cylindrical fiber which has small holes on its surface and whose outer diameter is approximately 0.3~3 mm. Therefore, it has benefits in that the filtration area per unit capacity is large, and pressure resistance is good. A filter is formed by bundling many pieces of the hollow yarn and hardening both ends with resin, which is a bonding agent. This hollow yarn membrane filter is used as a filtration device for water treatment apparatuses.

The structure of this type of hollow yarn membrane filtration device will be explained below while referring to Figure 5. Figure 5 is a cross-sectional diagram of a hollow yarn membrane filtration device, where callout 1 in the diagram is the container main unit. The interior of this container main unit 1 is split into top and bottom by a diaphragm 3, where the lower space is a filtration chamber 1a, and the upper space is a processing fluid chamber 1b. The hollow yarn membrane filter 2 is hanging down from the aforesaid diaphragm 3 within the aforesaid filtration chamber 1a. The aforesaid

hollow yarn membrane filter 2 has a structure whereby multiple pieces of hollow yarn 2a are bundled at the outer circumference of a support member 4, and their upper and lower ends are secured by bonding agent filling sections 6, and, in addition, bundle securing members 7 are installed and secured from the outer circumferences thereof. Also, in the apparatus shown in Figure 1, the hollow yarn membrane filter 2 with the aforesaid configuration is connected in two stages in a perpendicular direction, where callout 8 in the diagram is the connecting tube which is used when this is done. A fluid supply pipe 10 which connects with the filtration chamber 1a is connected to the lower end of the aforesaid container main unit 1 while a processing fluid discharge pipe 11 which connects with the processing fluid chamber 1b is connected to the upper end. A shut-off valve 12 is positioned along the aforesaid fluid supply pipe 10, and a concentrated fluid discharge pipe 13 is branch connected. A shut-off valve 14 is positioned along this concentrated fluid discharge pipe 13. The fluid which has been supplied to the interior of the filtration chamber 1a via the aforesaid fluid supply pipe 10 is filtered when it passes through the hollow yarn membrane filter 2, and it is discharged via the hollow sections of the respective pieces of hollow yarn 2a.

In the aforesaid configuration, when the differential pressure before and after the hollow yarn membrane filter 2 rises due to filtration and reaches a specified value, a backwash operation is executed to perform an operation to wash off the solid portion which has adhered to the surfaces of the respective pieces of hollow yarn 2a. That is, a pressurized gas for backwashing is supplied inside the respective pieces of hollow yarn 2a of the hollow yarn membrane filter 2 via the aforesaid processing fluid discharge pipe 11. Simultaneously, a bubbling operation is executed from below the hollow yarn membrane filter 2. That is, a bubbling pipe 15 is arranged below the hollow yarn membrane filter 2 within the aforesaid container main unit 1, and bubble holes 16 are formed in the lower surface of this bubbling pipe 15. The aforesaid bubbling pipe 15 is connected to an air supply pipe 17 which has a shut-off valve 18. By supplying air to the aforesaid bubbling pipe 15 via the aforesaid air supply pipe 17, bubbles are generated from the aforesaid bubble holes 16. The hollow yarn membrane filter 2 is subject to bubbling by the aforesaid bubbles to improve the washing effect. An overflow pipe 19 is connected to the container main unit 1 so that it is positioned below the aforesaid diaphragm 3, and a shut-off valve 20 is positioned along said overflow pipe 19. Callout 21 in the diagram is a protecting tube, and this protecting tube 21 which allows the bubbles from the aforesaid bubbling to be effectively introduced into the hollow yarn membrane filter 2.

The current situation is such that, when backwashing is performed on a hollow yarn membrane filter 2 with the aforesaid configuration, the question of what degree of excess length should be set for the length (L1; a value larger than L2, since there is some looseness in the gap which is the aforesaid L2) of the hollow yarn 2a arranged between the two ends with respect to the distance (shown by callout L2 in Figure 5) between the two ends, which was determined according to the bonding agent filling sections 6 at both ends, in order to effectively perform the aforesaid bubbling and prevent damage to the hollow yarn 2a has not been taken into account. Conventionally, it has been set with

excess length of approximately 5 percent. However, situations in which the multiple pieces of hollow yarn 2a become twisted then bent and damage have occurred as filtration and backwashing were repeated. This is thought to be because the hollow yarn 2a consists of a polymeric material, and its specific gravity is almost equal to that of water, which is the main constituent of the processed fluid, so the hollow yarn 2a whirls up, then bends and becomes damaged. As a means of solving these types of problems, the excess length, which has been set to approximately 5 percent as mentioned above, may be shortened or eliminated. However, the following problems occur when such a method is adopted.

1) First, when the range of oscillation of the hollow yarn 2a when the aforesaid bubbling is performed is restricted more than is necessary, it is impossible to obtain a sufficient bubbling effect.

2) When the hollow yarn membrane filter 2 is bundled in the aforesaid way in a condition in which multiple pieces of hollow yarn 2a are densely arranged, and the excess length is decreased, the effects are such that the fluid to be processed does not flow efficiently between the respective pieces of hollow yarn 2a, and, therefore, only the hollow yarn 2a which is positioned at the outer circumference of the hollow yarn membrane filter 2 is provided for filtration. This is also undesirable from the standpoint of filtration efficiency, and it results in a phenomenon by which solid portion adheres only to the hollow yarn 2a positioned at the outer circumference.

3) Also, when backwashing is executed, there is a problem in that the solid portion which has been separated by said backwashing accumulates among the pieces of hollow yarn 2a, and removal of the separated solid portion is not performed effectively. This is because, ultimately, the flow characteristics among the pieces of hollow yarn 2a are poor because the hollow yarn 2a is densely arranged in the same way as the aforementioned 2), and the excess length is short.

Problems To Be Solved By the Invention

In this way, in conventional hollow yarn membrane filters, there has not been sufficient study with respect to how to determine the excess length, resulting in various problems. The present invention was designed taking these points into account, and its objective is to provide a hollow yarn membrane filter equipped with an excess length which makes it possible to perform effective backwashing while preventing damage to the hollow yarn.

Configuration of the Invention

Means To Solve Problems

In the context of a hollow yarn membrane filter in which multiple pieces of hollow yarn are bundled, filling and securing with bonding agent are performed in such a way that both bundled ends open, a bundle securing member is installed and secured at

the outer circumference of the bonding agent filling sections filled with the aforesaid bonding agent, and the aforesaid bonding agent filling sections at both ends are connected across a specified length; the hollow yarn membrane filter of the present invention is characterized in that the length (L1) of the hollow yarn between the aforesaid two bonding agent filling sections is set so that there is a specified excess length (ΔL) with respect to the gap (L2) between the aforesaid two bonding agent filling sections, and this excess length (ΔL) satisfies the following conditions:

$0.01 \leq (\Delta L/L1) \leq 0.04$

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections
L2: The gap between the two bonding agent filling sections
ΔL: (L1 - L2)

Action

Setting the excess length of the hollow yarn within the aforesaid range effectively solves such problems as the drop in the backwashing effect which occurs due to the excess length being too small as it eliminates the bending and damage which result from the twisting of the hollow yarn which occurs due to the excess length being too great.

Embodiments

An embodiment of the present invention will be explained while referring to Figures 1 through 4. The same portions as in the conventional example are indicated by the same callouts, and explanations of these portions have been omitted. Figure 1 is cross-sectional diagram of the configuration of the hollow yarn membrane filter 2, where the length (L1) of the hollow yarn 2a arranged between the two bonding agent filling sections 6 at the top and bottom ends in a condition which is somewhat loosened has an excess length (ΔL) with respect to the distance (L2) between the aforesaid two bonding agent filling sections 6, and this excess length (ΔL) is set within the following range. $0.01 \leq (\Delta L/L1) \leq 0.04$.....(I)

where,

L1: The length of the hollow yarn arranged between the two bonding agent filling sections
L2: The gap between the two bonding agent filling sections
ΔL: (L1 - L2)

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The reason that the excess length (ΔL) is set within this range is to effectively eliminate both the harmful effects resulting from the excess length being too great and the harmful effects resulting from the excess length being too small, which will be explained below while referring to Figures 3 and 4.

Figure 3 shows the proportion (%) of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a on the horizontal axis and the number of bent sections of the hollow yarn 2a (among 1,000 pieces of yarn) on the vertical axis. According to this diagram, when the proportion of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a is 4 or less, the number of pieces of hollow yarn 2a in which bent sections have occurred is extremely small. Therefore, if the excess length (ΔL) proportion is set to 4 or less, it is possible to effectively eliminate harmful effects resulting from the excess length being large. The lower limit value will be explained while referring to Figure 4. Figure 4 shows the proportion (%) of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a on the horizontal axis and the backwashing efficiency (solid portion volume separated by backwashing /captured solid portion volume, %) on the vertical axis. As we can see from Figure 4, when the proportion of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a is 1 or less, backwash efficiency quickly deteriorates. As shown in Figure 2, this is because it is necessary for the hollow yarn 2a to oscillate to certain extent when bubbling is performed during backwashing, and the solid portion gets shaken off by said oscillation. Moreover, the following has been observed. Because movement of the hollow yarn 2a is limited more than is necessary when the excess length (ΔL) proportion has been set to less than 1, filtrate does not flow in the vicinity of the hollow yarn 2a of the center section of the hollow yarn membrane filter 2, resulting in only the outer circumference portion of the hollow yarn 2a being provided for filtration. This may be observed from the fact that the solid portion only adheres to the hollow yarn 2a positioned at the outer circumference. It has also been confirmed that when a setting of less than 1 is used simultaneously with this, the solid portion which has been separated during backwashing flows into the hollow yarn membrane filter 2 and cannot be effectively removed. For this reason, the proportion of the excess length (ΔL) with respect to the length (L1) of the hollow yarn 2a has been given a lower limit value of 1.

The above embodiment is able to exhibit the following benefits.

1) First, it is possible to effectively prevent the situation whereby the hollow yarn 2a whirls up during backwashing and therefore becomes twisted and bent or damaged.

2) Also, effective backwashing becomes possible due to the hollow yarn 2a oscillating to an appropriate degree during backwashing.

3) In addition, the solid portion separated during backwashing does not flow into the hollow yarn membrane filter 2.

4) Also, filtrate flows efficiently even around the hollow yarn 2a positioned at the center section of the hollow yarn membrane filter 2 even during filtration, so it is possible to prevent the situation whereby filtration is only performed at the outer circumference section and to provide effective filtration.

Benefits of the Invention

As explained in detail above, through the hollow yarn membrane filter resulting from the present invention, there are great benefits in that it is possible to prevent the situation whereby the hollow yarn whirls up and therefore becomes twisted and bent or damaged and to provide effective backwashing.

4. Brief Explanation of the Figures

Figures 1 through 4 are diagrams which show an embodiment of the present invention, where Figure 1 is a front view of a hollow yarn membrane filter; Figure 2 is a front view of a hollow yarn membrane filter which shows the action during backwashing; Figure 3 is a characteristics diagram which shows changes in the number of pieces in which bent sections occur when the excess length of the hollow yarn is changed; Figure 4 is a characteristics diagram which shows changes in the backwashing effect when the excess length of the hollow yarn is changed; and Figure 5 is a cross-sectional diagram of a hollow yarn membrane filtration apparatus.

2 Hollow yarn membrane filter
2a Hollow yarn
4 Support member
6 Bonding agent filling section
7 Bundle securing member

Figure 1

Figure 2

1. Air

Figure 3

1. The number of pieces of hollow yarn in which bent sections occur (per 1,000 pieces of hollow yarn) (pieces)
2.

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The proportion of excess length (ΔL) with respect to the length L2 of the hollow yarn (%).

Figure 4

3. Backwashing efficiency (solid portion volume separated by backwashing/captured solid portion volume) (%)

4. The proportion of excess length (ΔL) with respect to the length L2 of the hollow yarn

Figure 5